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INVESTOR IN PEOPLE

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I also certify that the attached copy of the request for grant of a Patent (Form 1/77) bears an amendment, effected by this office, following a request by the applicant and agreed to by the Comptroller-General.

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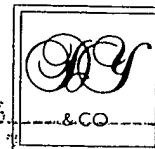
Dated 4 December 2003

# Patents Form 1/77

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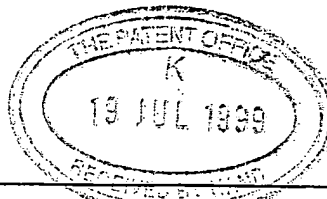
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20 JUL 99 E463187-13 002246  
P01/7700 0.00 - 9916906.2



## Request for a grant of a patent

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The Patent Office

Cardiff Road  
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Gwent NP9 1RH

1. Your reference

P006791GB MP

2. Patent application number  
(The Patent Office will fill in this part)

9916906.2

19 JUL 1999

3. Full name, address and postcode of the or of each applicant  
(underline all surnames)

DEK PRINTING MACHINES LTD  
11 ALBANY ROAD  
GRANBY INDUSTRIAL ESTATE  
WEYMOUTH  
DORSET  
DT4 9TH

Patents ADP number (if you know it)

4333 306200

If the applicant is a corporate body, give the country/state of its incorporation

UNITED KINGDOM

4. Title of the invention

"IMPROVEMENTS RELATING TO SCREEN  
PRINTING"

5. Name of your agent (if you have one)

D YOUNG & CO  
21-NEW FETTER LANE  
LONDON  
EC4A 1DA

Fry Heath + Spence  
219 9-2 / CPJL 9-6  
53 HIGH STREET  
WIMBORNE  
DORSET  
SP1 2BN  
5280273001

"Address for service" in the United Kingdom to which all correspondence should be sent  
(including the postcode)

Fry Heath + Spence  
The Gables, 105 Great Rd  
Horsley Surrey  
RH6 1DA

Patents ADP number (if you have one)

59006

6. If you are declaring priority from one or more earlier patent applications, give the country and date of filing of the or each of these earlier applications and (if you know it) the or each application number

Country

Priority application  
number  
(if you know it)

Date of filing  
(day/month/year)

7. If this application is divided or otherwise derived from an earlier UK application, give the number and filing date of the earlier application

Number of earlier  
application

Date of filing  
(day/month/year)

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? (Answer 'Yes' if:  
a) any applicant named in part 3 is not an inventor, or  
b) there is an inventor who is not named as an applicant, or  
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Continuation sheets of this form NO

Description 7 /

Claims(s) 2 /

Abstract 1 /

Drawing(s) 3 + 3 /

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Priority documents NONE

Translations of priority documents NONE

Statement of inventorship and right to grant of a patent (Patents Form 7/77) ONE /

Request for preliminary examination and search (Patents Form 9/77) ONE /

Request for substantive examination (Patents Form 10/77) NONE

Any other documents (please specify) NO

11. I/We request the grant of a patent on the basis of this application.

Signature

Date

D Young & Co  
D YOUNG & CO  
Agents for the Applicants

19 07 99

12. Name and daytime telephone number of the person to contact in the United Kingdom W M C PURVIS 023 8063 4816

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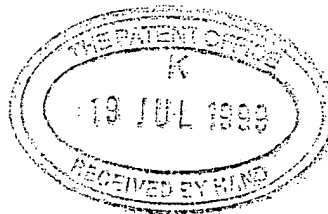
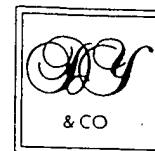
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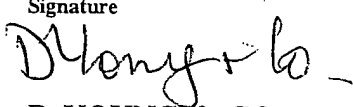
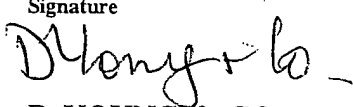
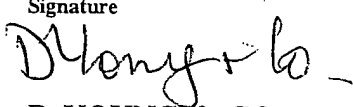
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## Statement of inventorship and of right to grant of a patent

1.	Your reference	P006791GB MP						
2.	Patent application number (if you know it)	9916906.2 19 JUL 1999						
3.	Full name of the or of each applicant	DEK PRINTING MACHINES LTD						
4.	Title of the invention	"IMPROVEMENTS RELATING TO SCREEN PRINTING"						
5.	State how the applicant(s) derived the right from the inventor(s) to be granted a patent	BY VIRTUE OF AN ASSIGNMENT DATED 7 JULY 1999						
6.	How many, if any, additional Patents Forms 7/77 are attached to this form? (see note (c))	0						
7.	<p>I/We believe that the person(s) named over the page (and on any extra copies of this forms) is/are the inventor(s) of the invention which the above patent relates to</p> <table border="0"><tr><td>Signature</td><td>Date</td></tr><tr><td></td><td>19 07 99</td></tr><tr><td colspan="2">D YOUNG &amp; CO Agents for the Applicants</td></tr></table>		Signature	Date		19 07 99	D YOUNG & CO Agents for the Applicants	
Signature	Date							
	19 07 99							
D YOUNG & CO Agents for the Applicants								
8.	Name and daytime telephone number of the person to contact in the United Kingdom	W M C PURVIS 023 8063 4816						

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Enter the full names, addresses and postcodes of the inventors in the boxes and underline the surnames

LAMBERT, PHILIP JOHN

5 PUGMILL LANE  
CHICKERELL  
WEYMOUTH  
DORSET  
DT3 4PB

7425432002

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DUPLICATE

IMPROVEMENTS RELATING TO SCREEN PRINTING

The invention relates to screen printing and particularly to screen printing wherein pasty product to be printed is contained within a printhead and is pressed  
5 through the printhead by applied pressure.

International Patent Specification WO 98/16387 discloses such a printhead and discloses that lateral movement of the printhead over a screen to be printed generates circulating flows within the pasty product as a result of excess pasty product being  
10 lifted from the screen by that one of a pair of wiper blades which projects forwardly having regard to the direction of movement of the printhead but is at the trailing side thereof.

It is a known technique in the assembly of printed circuit boards, to first deposit  
15 solder paste where connections are to be made with components, prior to placing the components, and then heating the assembly to reflow the paste and complete the connections. Screen printing machines can be used to deposit the solder paste through the apertures of a stencil or screen.

20 Solder paste consists of metallic microspheres of solder joined by an organic material or flux. The metallic content typically makes up 50% of the volume but up to 90% of the weight of the paste. The viscous flux consists of rheologic agents, adhesive agents and cleaning agents, some of these are thixotropic and others are volatile solvents.

25

A typical print will comprise a multiplicity of small blocks of paste and for consistent quality, it is essential that each block contains the same proportions of each constituent material. This requires a consistent homogeneous distribution of the materials within the paste.

30

As the complexity of printed circuit boards has increased, the size of the print and hence the stencil aperture has decreased, resulting in increased difficulty in filling the apertures with paste and obtaining a good print. The thixotropic property of the paste has the effect that the relative movement of regions within the paste causes a process of shear thinning to locally reduce the viscosity of the paste and reduce this difficulty.

According to one aspect of the invention a printhead for screen printing, through which printhead pasty product to be printed can be pressed by applied pressure, comprises a chamber into which pasty product can be charged and in which it can be placed under pressure, an exit slot from said chamber for pasty product to be printed and a downstream chamber in communication with the exit slot, wherein the downstream chamber is closed at an exit end thereof in use by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed and the downstream chamber is subdivided by vanes to define pasty product flow paths along which pasty product will flow as a result of movement of the printhead over the stencil in use, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and of movement of the pasty product through the exit slot due to the applied pressure.

20

Such a printhead can provide enhanced shear thinning and better stencil aperture filling to reduce the incidence of poor quality printing.

Advantageously the vanes comprise two vanes provided one on each side of the exit slot and defining between their lower ends an elongate nozzle aperture directed towards the stencil.

Preferably the downstream chamber subdivided by the vanes is provided in the form of two lobes, one above each of the respective wiper blades and a roof wall of each lobe of the lobes is of arcuate configuration to define an arcuate perimeter of the respective circulating flow path.

Preferably the chamber can be charged by injecting paste through one or more parts.

5           Alternatively the chamber can be charged by opening the printhead and inserting a replaceable cassette of paste.

According to another aspect of the invention thereto is provided a method of screen printing using a printhead through which printhead pasty product to be printed  
10 is pressed by applied pressure, comprising charging pasty product into a chamber and placing it under pressure for movement towards an exit slot from said chamber and into a downstream chamber in communication with the exit slot, the downstream chamber being closed at an exit end thereof by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed including the step of  
15 subdividing the downstream chamber by vanes to define pasty product flow paths along which past product flows as a result of movement of the printhead over the stencil, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and of movement of the pasty product through the exit slot due to the applied pressure.

20

The invention is diagrammatically illustrated by way of example in the accompanying drawings, in which;

Fig 1 is an illustration of traditional screen printing;

Fig 2 shows a printhead of the kind disclosed in Patent Specification WO  
25 98/16387;

Figs 3A, 3B and 3C show defects which can occur during screen printing;

Fig 4 is a respective view from one end, one side and below of a printhead according to the invention for screen printing;

Fig 5 is a sectional view through the printhead of Fig 4; and

30

Fig 6 is a view similar to Fig 5 showing the printhead in operation.

In traditional screen printing, as shown in Fig 1, an inclined squeegee or wiper blade 1, pushes a volume of paste 5, across a stencil 2, filling an aperture 3 of the stencil 2 to provide a print on a circuit board 4. The forward movement of the squeegee, in the direction F1, causes a downward force F2, on the paste 5, to force it into the aperture 3, and in conjunction with the adhesion of the paste 5, to the stencil 2, causes the paste to roll across the stencil as shown by arrows 6, shear thinning the paste. Known problems are that exposure of the paste to atmosphere results in evaporation of solvents and drying of the paste, and increasing the speed in order to increase the pressure to force the paste into the stencil apertures, not only reduces the time available to fill the aperture but can also cause the paste to slide across the stencil, reducing the rolling effect and resulting shear thinning.

Printheads have been previously proposed, for example in Patent Specification USA-4622 239 to Schoenthaler & Wojcik, that enclose the paste to overcome the problems of evaporation, but they have not addressed the problem of setting a suitable print speed. Patent Specification WO 90/20088 to Ford attempts to overcome both of these problems by applying pressure directly to the paste, however there is no rolling of the paste or resultant shear thinning and a very high pressure is required on the paste. This high pressure can result in the separation of metallic and flux components of the paste and therefore inconsistent printing.

Patent Specification WO 98/16387 to Novatec as shown in Fig 2 hereto overcomes most of these problems, in that paste 15, is totally enclosed by a printhead body 18, a piston 19, wiper blades 11 and the stencil 2, overcoming the problems of evaporation and, during printing, the angle of the wiper blades 11, lifts the paste from the stencil 2 and assists in the rolling of the paste 15 as shown by the arrows 16. This rolling action, further assisted by a grid 17, shear thins the paste, keeping the required pressure F2 applied by the piston 19, low and any separation of the paste is cancelled by the rolling action remixing it. Further the pressure applied to the paste F2, is

independent of the speed of movement of the head. However, in some circumstances even this does not produce sufficient shear thinning of the paste for a perfect print.

If the paste is not sufficiently thinned, it is possible for there to be incomplete  
5 filling of the stencil aperture 3 as shown in Fig 3a, so that, when the wiper blade 11 shears the paste 15 over the aperture 3, what paste there is in the aperture 3 is pushed to one end, as shown in Fig 3b, resulting in only a partial print. In extreme cases, the paste in the aperture 3 may not be pushed into sufficient contact with the board 4, so that when the board 4 and the stencil 2 are separated, there is insufficient adhesion to  
10 the board 4 and the paste remains in the stencil, as shown in Fig 3c, resulting in virtually no print at all and with the added problem that the paste 15, left in the stencil 2, can dry out, giving problems with subsequent prints. These problems have been made worse by recent trends in miniaturisation that have led to smaller apertures 3 effectively reducing the area of paste to board contact relative to the area of paste to  
15 aperture wall contact.

Referring to Figs 4, 5 and 6, a printhead 51 is, in use, forced into contact with the stencil 2 and the underlying circuit board 4. A force  $F_2$  is applied to a flexible diaphragm 55 pressurising the paste in a reservoir 56 and forcing it through an exit slot  
20 60, passages 61, 62 and an elongate nozzle 52 into lower chambers 58 and 59, where it is forced into contact with the stencil 2. The lower chambers 58, 59 have arcuate roof walls 58a, 59a and the elongate nozzle 52 is formed by a pair of vanes 52a, 52b which at their upper end extend parallel to the arcuate roof walls and define therewith the passages 61, 62 and at their lower ends define between them an elongate nozzle  
25 aperture 63

When a force  $F_1$  is applied to move the printhead 51 across the stencil 2, the resultant movement in conjunction with the adhesion of the paste to the stencil 2, causes a relative movement between the paste and the printhead as shown by the broad  
30 arrows 64 in Fig 6. Paste from the leading lower chamber 59 is drawn by adhesion to the stencil 2 between the nozzle 52 and the stencil 2, causing shear thinning of the

paste in this region. This increases the pressure within the trailing lower chamber 58 and paste is forced back to the leading lower chamber 59 through the passages 62 and 61, further shear thinning the paste. The aperture 63 in the nozzle 52 allows the downward force F2 being applied to the paste in the reservoir 56 to be directly applied to the freshly shear thinned paste in the region directly below the nozzle 52, forcing the paste into an aperture 3 in the stencil 2.

These features can result in better shear thinning than any of the previous systems, particularly in the critical region between the nozzle 52 and the stencil 2 and much better packing of paste into the stencil apertures. Wiper blades 53 are then able to cleanly cut off the paste across the top of the stencil aperture 3, without leaving any voids in the aperture 3, and establish good contact between the paste and the board 4, over the full area of the stencil aperture 3, thereby ensuring good separation of the paste from the stencil resulting in good quality printing.

The nozzle 52, runs the full length of the printhead as can be seen in Fig 4 and the internal void of the printhead is effectively divided into four zones comprising the reservoir 56, a space 57 within the nozzle 52 and the lower chambers 58, 59.

The paste reservoir 56 is formed by the main body of the printhead 51 and the flexible diaphragm 55. This reservoir can be charged with solder paste or other viscous material through one or more ports 65, Fig. 4. The lower surface of the reservoir 56 contains the exit slot 60 that extends the full length of the printhead and allows paste to pass into the space 57 within the nozzle 52, where in use it will mix with paste circulating between the lower chambers 58 and 59. These lower chambers 58 and 59 are defined by the wiper blades 53, the arcuate walls 58a, 59a, the nozzle 52, end sealing blocks 54 and the stencil 2. Therefore when the printhead is in contact with the stencil 2, the paste is totally enclosed.

It can be seen in Fig 4 that the printhead is symmetrical and although the above description of its operation is given for movement in the direction of F1, it can equally be used for printing in the opposite direction.

5       The shape and size of the nozzle 52, the space 57 and the chambers 58 and 59 shown in Fig 5 illustrate the principle of the invention. The widths of the exit slot 60 and the nozzle aperture 63, the width and length of the passage 61 and 62, and the clearance of the lower edge of the nozzle 52, all have an effect on the operation of the system and may be chosen to change the balance between shear thinning and the  
10       maximum feed rate of the paste.

Alternative designs for the reservoir 56 are clearly possible, such as the interchangeable cassette system as detailed in PCT application PCT/EP97/05761.

15

20

CLAIMS

1. A printhead for screen printing, through which printhead pasty product to be printed can be pressed by applied pressure, comprising a chamber into which pasty product can be charged and in which it can be placed under pressure, an exit slot from said chamber for pasty product to be printed and a downstream chamber in communication with the exit slot, wherein the downstream chamber is closed at an exit end thereof in use by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed and the downstream chamber is subdivided by vanes to define pasty product flow paths along which pasty product will flow as a result of movement of the printhead over the stencil in use, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and of movement of the pasty product through the exit slot due to the applied pressure.
2. A printhead according to Claim 1, in which the vanes comprise two vanes provided one on each side of the exit slot and defining between their lower ends an elongate nozzle aperture directed towards the stencil.
3. A printhead according to Claim 1 or Claim 2, in which the downstream chamber subdivided by the vanes is provided in the form of two lobes, one above each of the respective wiper blades and a roof wall of each lobe of the lobes is of arcuate configuration to define an arcuate perimeter of the respective circulating flow path.
4. A printhead according to any one of Claims 1 to 3, in which the chamber can be charged by injecting paste through one or more ports.
5. A printhead according to any one of Claims 1 to 3, in which the chamber can be charged by opening the printhead and inserting a replaceable cassette of paste.

6. A method of screen printing using a printhead , through which printhead pasty product to be printed is pressed by applied pressure, comprising charging pasty product into a chamber and placing it under pressure for movement towards an exit slot from said chamber and into a downstream chamber in communication with the exit slot, the downstream chamber being closed at an exit end thereof by flexible wiper blades and by a portion of a screen through which the pasty product is to be printed, including the step of subdividing the downstream chamber by vanes to define pasty product flow paths along which pasty product flows as a result of movement of the printhead over the stencil, the flow paths comprising circulating flow above the wiper blades and flow towards the stencil between the vanes as a result of the circulating flows and of movement of the pasty product through the exit slot due to the applied pressure.

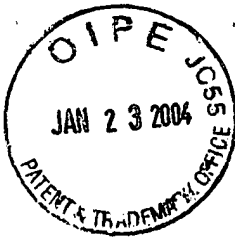
7. A printhead for screen printing substantially as hereinbefore described and illustrated in Figures 4, 5 and 6 of the accompanying drawings.

**ABSTRACT**

A printhead for screen printing pasty products such as solder paste, has an upper chamber (56) which can be pressurised (F2), an exit slot (60) and a downstream chamber (58, 59) closed by wiper blades (53) and the stencil (2) to be printed and subdivided by vanes (52a, 52b) which form a nozzle (52) to define pasty product flow paths (64) along which pasty product can flow in circulating paths as a result of movement (F1) of the printhead across the stencil (2) to enhance shear thinning and mixing of the pasty product and better aperture (3) filling of the stencil (2).

10

Fig. 6.



1 / 3

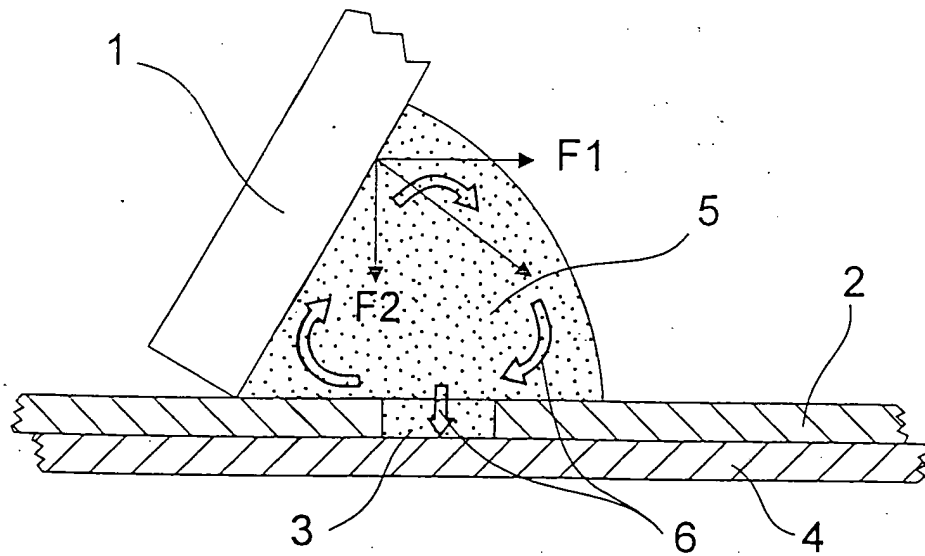
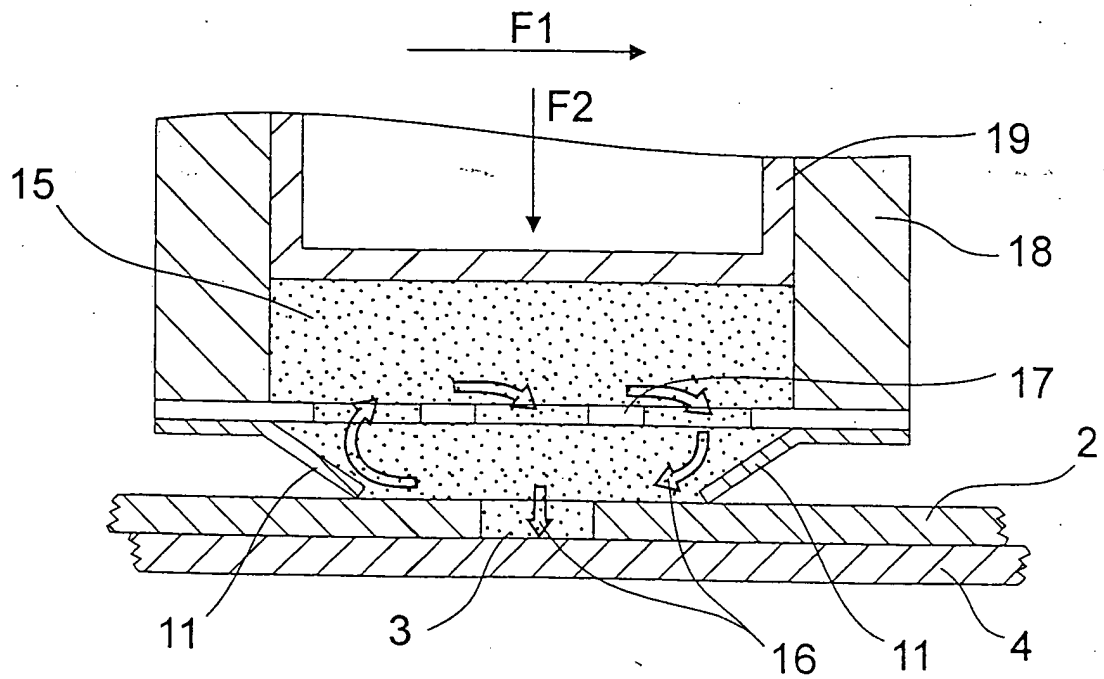
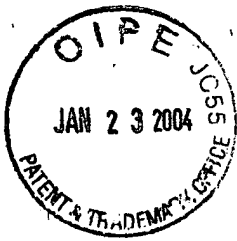


FIG. 1





2 / 3

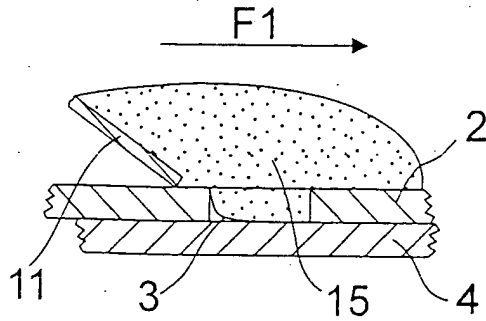


FIG. 3a

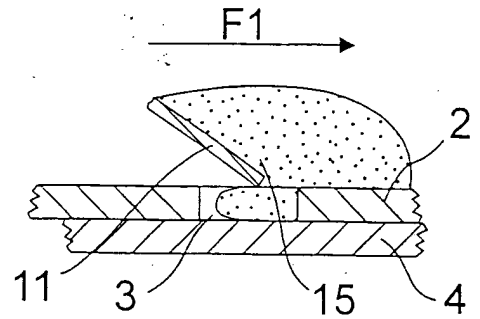


FIG. 3b

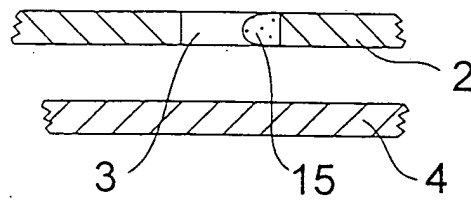


FIG. 3c

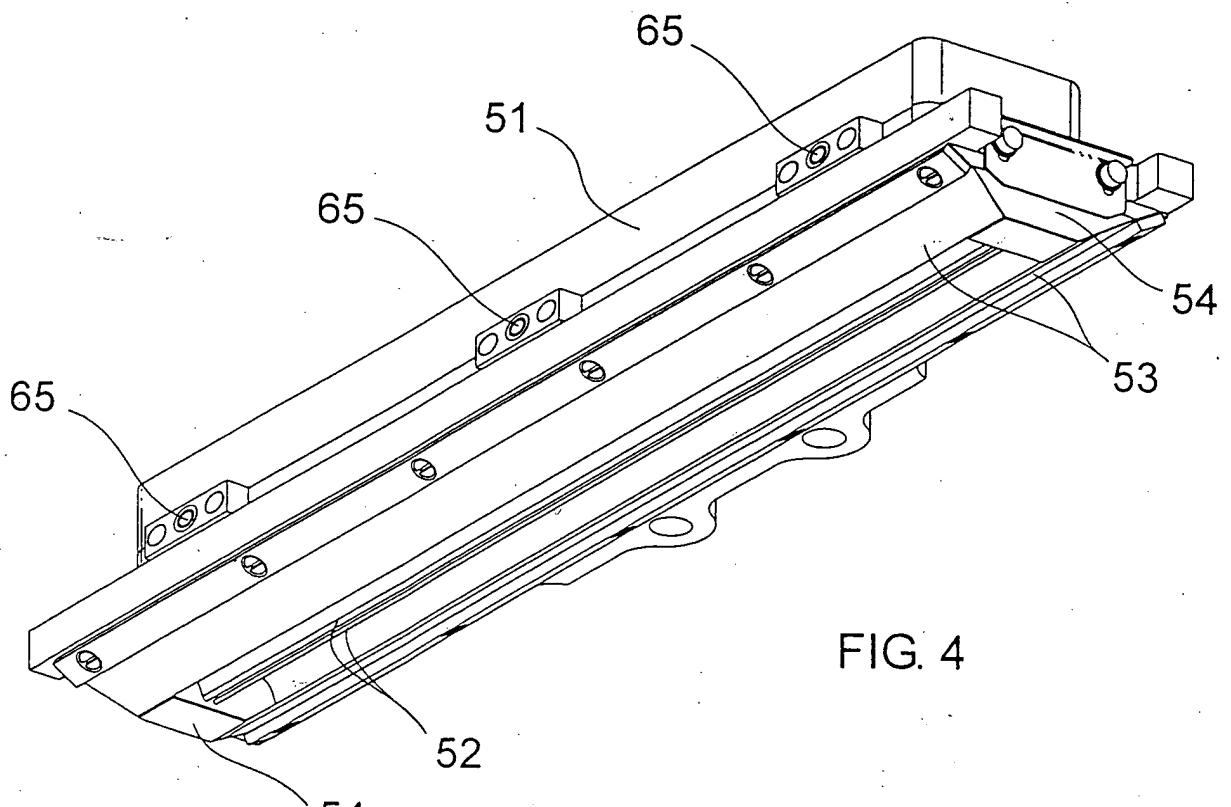
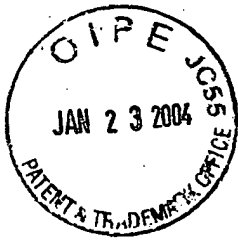


FIG. 4



3 / 3

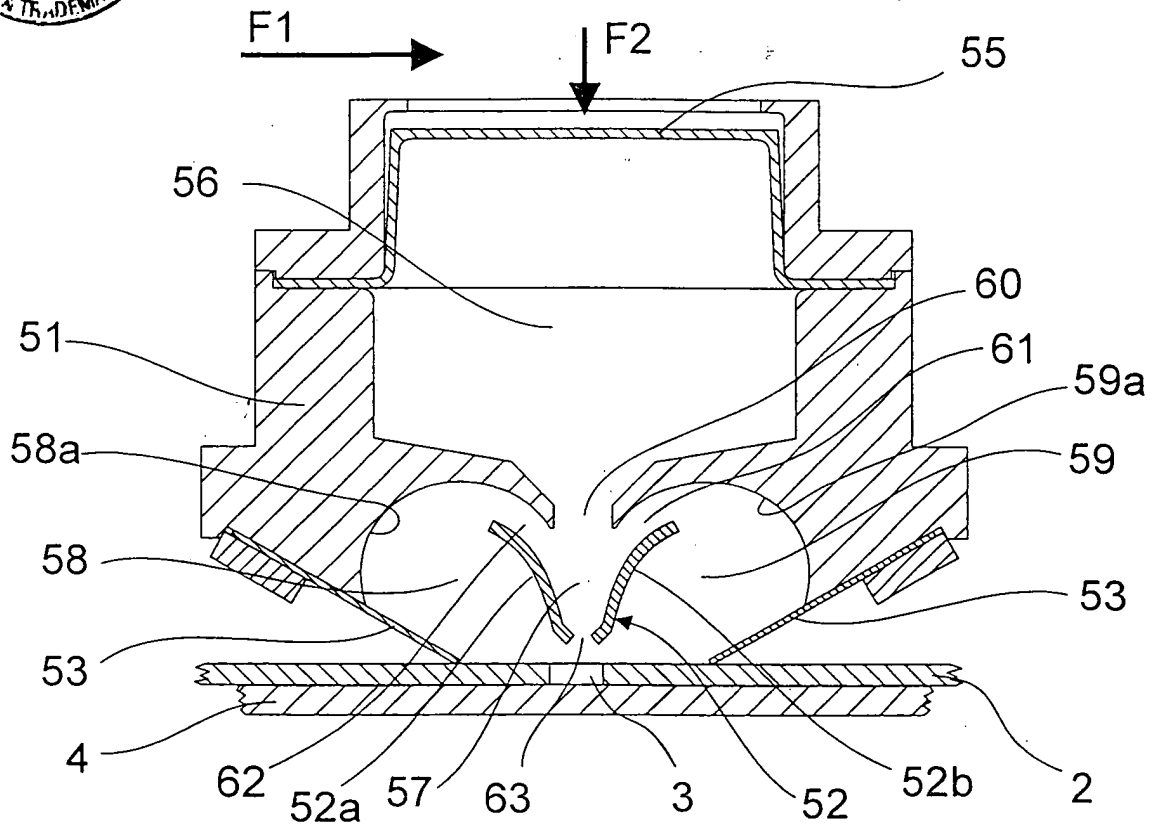


Fig. 5

